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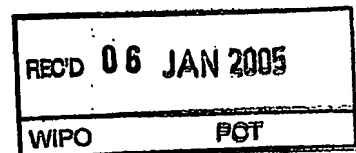
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Specification and Drawings, as originally filed, with Application for Patent Serial No:  
2,450,560, on November 24, 2003, by MANFRED A. A. LUPKE  
and STEFAN A. LUPKE, for "Pipe Molding System with Vacuum and Temperature  
Controls of Cooling Plugs"



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**ABSTRACT OF THE DISCLOSURE**

A pipe mold produces plastic pipe with an internal wall having a first wall portion and a second wall  
5 portion. The pipe mold includes a cooling plug to assist in setting the pipe wall. The first wall portion of the pipe wall travels over and is in contact with the cooling plug applying heat directly to and providing a first  
10 temperature control to prevent access of cooling of the cooling plug. The second wall portion of the internal pipe wall travels over and is spaced outwardly away from the cooling plug. The pipe mold includes a second  
15 temperature control which operates in preventing the access of plug cooling as the second wall portion of the internal wall of the pipe travels over the cooling plug.

- 1 -

**PIPE MOLDING SYSTEM WITH VACUUM AND TEMPERATURE CONTROLS**  
**OF COOLING PLUGS**

**FIELD OF THE INVENTION**

5           The present invention relates to a plastic pipe mold of the type using a moving mold tunnel including a cooling plug for setting of the pipe shape within the moving mold tunnel.

10   **BACKGROUND OF THE INVENTION**

          In the pipe molding art, it is known to use mold blocks which move through a molding path commonly referred to as a moving mold tunnel. The mold blocks are fed with molten plastic from a plastic extruder and the  
15   molten plastic is shaped to the contour of the mold block in the moving mold tunnel. Provided in the moving mold tunnel is a plastic setting device known in the industry as a cooling plug.

20           A conventional cooling plug is cooled typically by means of chilled water which is run through coils at the surface of the cooling plug. The internal wall of the plastic pipe may be pulled by vacuum onto the surface of the cooling plug to help in setting the shape of the pipe  
25   wall.

          The above described cooling plug operation is very efficient as long as there is continuous contact with the pipe wall. However, some pipes are made with internal  
30   walls which have wall portions which are not in contact with the cooling plug. These wall portions may for example be coupling portions built directly into the wall of the pipe. Such coupling portions have a greater internal diameter than the main body of the pipe and as  
35   such are spaced outwardly away from the cooling plug.

- 2 -

The formation of the main pipe body and the coupling portions in the pipe wall is a continuous process. Therefore, following the formation of a coupling portion is a further wall portion which returns to a diameter which once again contacts the exterior surface of the cooling plug. However, the cooling plug during the time of forming the coupling wall portion drops to an unacceptably low temperature. This is because the chilling of the cooling plug is normally offset by the contact with the heated molten plastic. When the heated molten plastic is not in contact with the cooling plug as is the case during the formation of the coupling portion there is nothing to control the drop in temperature of the cooling plug. When this happens, the pipe wall portion following the coupling portion and coming into contact with the overly chilled cooling plug is cooled too much by the plug. This results in excessive, too rapid hardening and even cracking of the pipe wall. This continues until the temperature of the cooling plug has been brought back up to an acceptable level by further contact with the heated plastic of the pipe wall.

As a result of the above there is an undesirable loss of part of the pipe wall immediately following the coupling portion built into the pipe wall.

#### SUMMARY OF THE PRESENT INVENTION

The present invention provides a pipe molding system designed to overcome the problems noted immediately above. More particularly, a pipe molding system according to the present invention which produces plastic pipe includes a plurality of moving first mold block sections and moving second mold block sections. The first mold block sections close with the second mold block sections to form a moving mold tunnel. The system

- 3 -

includes means for feeding molten plastic to the first and second mold block sections to form the plastic pipe. Also provided is a cooling plug for setting the plastic in the moving mold tunnel.

5

The plastic pipe has an internal wall layer with a first wall portion which travels over and is in contact with the cooling plug and a second wall portion e.g., a belled coupling portion, which travels over and is spaced  
10 outwardly away from the cooling plug.

The first wall portion of the internal pipe wall layer applies heat directly to and provides a first temperature control to prevent excessive plug cooling as  
15 the first wall portion of the initial pipe wall layer travels over the cooling plug. The system further includes a second temperature control which operates to replace the first temperature control in preventing the excessive plug cooling as the second wall portion of the  
20 internal wall layer of the pipe travels over the cooling plug.

The second temperature control may be provided by varying the flow or temperature or both of the chilled  
25 water which is used to cool the cooling plug. Alternatively, the second temperature control may be provided by a heater which acts on the cooling plug while the second wall portion of the internal pipe wall layer passes over the cooling plug.

30

As a further preferred feature of the present invention, the cooling plug itself may have a plurality of plug sections with both vacuum and temperature controls being provided at each of the plug sections.  
35 These vacuum and temperature controls will operate in accordance with which particular wall portion i.e., the

- 4 -

first or the second wall portion is located over the respective cooling plug sections.

**BRIEF DESCRIPTION OF THE DRAWINGS**

5           The above as well as other advantages and features of the present invention will be described in greater detail according to the preferred embodiments of the present invention in which;

10           Figure 1 is a side view of an overall pipe molding apparatus according to a preferred embodiment of the present invention;

15           Figure 2 is a sectional view through the mold tunnel of the pipe molding apparatus of Figure 1;

20           Figure 3 is a schematic view showing the die tooling and cooling plug assembly from the apparatus of Figure 1; and

25           Figures 4 through 7 show different stages of movement of plastic pipe formed in the apparatus of Figure 1 over the die tooling shown in Figure 3.

**DETAILED DESCRIPTION ACCORDING TO THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION IN WHICH:**

30           Figure 1 shows a pipe molding apparatus generally indicated at 1. This apparatus includes an extruder 3 which feeds molten plastic through die tooling 5 to a moving mold tunnel generally indicated at 11 of apparatus 1. Mold tunnel 11 is formed by mold block sections 7 and 9 which travel around endless belts. These mold block sections close with one another as they travel through mold tunnel 11.

35           Figure 2 of the drawings shows that mold block

- 5 -

sections 7 and 9 have internal faces with varying contours. More particularly, some of the mold block sections include a contour generally indicated at 13 which is essentially a sine wave contour. Others of the mold block sections include a more open contoured face region 15. Note that the sine wave contour of the mold block faces is provided to either side of the more open contour region 15.

Figure 2 also shows that die tooling 5 includes a pair of channels 17 and 19. These channels receive the molten plastic from extruder 3 and feed that molten plastic through die tooling 5 onto the interior faces of mold blocks 7 and 9.

Provided downstream of the channels 17 and 19 is a cooling plug generally indicated at 35.

Figures 4 through 7 show the pipe wall 21 which is formed using the die tooling of Figure 3. This pipe wall has first and second wall portions. The first wall portion is formed by a smooth flat interior wall layer 25 secured to the troughs of a corrugated exterior wall layer 23. The wall portion formed by smooth interior wall layer 25 in corrugations 23 is shaped by the contoured region 13 of the faces of the mold block sections.

The second wall portion comprises a belled coupling 27. In this belled coupling the inner and outer pipe wall layers are secured continuously against one another. The belled coupling is shaped in the face region 15 of mold blocks 7 and 9.

As is known in the art, the molten plastic is fed through passage 17 directly into the corrugations 13 and

- 6 -

also directly into the bell forming portion 15 of the mold block faces. Suction may be used to help draw the molten plastic into these areas of the mold block faces. This forms the outer layer of the pipe wall.

5

In order to form the inner layer of the pipe wall the molten plastic is fed through passage 19 onto the bases of the corrugations 13 and further onto the interior surface of the belled coupling formed in the outer pipe wall layer. This pipe forming technique is known in the industry.

10

The key to the present invention lies in the control of the cooling plug 35 which is best seen having reference to Figures 3 through 7 of the drawings.

15

In order to best describe how the pipe wall is formed relative to the cooling plug, the first wall portion as described above will be referred to as the main pipe body. The belled coupling portion will be referred by that name.

20

As best seen in Figure 4 of the drawings, the main body portion of the pipe and more particularly the inner wall layer of the main body portion of the pipe travels over and is in direct contact with the exterior surface of the cooling plug. The cooling plug as will be described later in greater detail is preferably cooled by chilled water. The temperature of the chilled water is at a level such that the cooling plug will set, without damaging the plastic in the pipe wall. In order to determine the temperature of the chilling water the compensating or cooling offsetting effect of the plastic in the pipe wall must be taken into account. In other words, the first wall portion of the pipe because it is in direct contact with the cooling plug and because it is

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- 7 -

in an essentially molten condition when it reaches the cooling plug has a tendency to heat up the cooling plug. The chilled water is therefore set at a relatively low temperature in order to negate or offset the heating effect of the pipe wall on the cooling plug.

As is to be understood from the description above the first wall portion therefore provides a temperature control to prevent excessive unwanted cooling of the plug.

Figure 6 is now to be compared with Figure 4. It will be seen in Figure 6 that the first or upstream end of the cooling plug 35 is not in contact with the second wall portion formed by the belled coupling in the pipe wall. The downstream end of the cooling plug is still however directly in contact with the pipe wall.

In the Figure 6 position the upstream end of the cooling plug in a conventional pipe forming apparatus drops to an unacceptably low temperature because it continues to be chilled to the same level without any offsetting heat being applied directly to the surface of the cooling plug. This is because the coupling bell is spaced outwardly away from the upstream end of the cooling plug. There may be some radiant heat from the pipe wall onto the cooling plug but this radiant heat from the pipe wall is not sufficient to hold the upstream end of the cooling plug at a desired operating temperature.

Due to the excessive cooling normally encountered prior to the present invention the upstream end of the cooling plug as described immediately above, the pipe wall and more particularly the main body of the pipe wall immediately following the coupling portion is adversely

- 8 -

over cooled by the part of the cooling plug which is not in direct contact with the plastic. This over cooling of the plastic material in the main body portion results in hardening and even cracking of at least the first or  
5 second corrugation in the main body portion of the pipe following the belled coupling. This ends up being waste material that needs to be cut out of the pipe.

10 In accordance with the present invention a second temperature control means is provided to prevent excessive cooling of the cooling plug when the pipe wall is not in direct contact with the cooling plug i.e., when the belled wall portion is traveling over the cooling  
15 plug.

The second control means can take a number of different forms. For example, it can be a water flow adjuster which adjusts flow of chilling water to the cooling plug. With lower flow rates the cooling plug will  
20 not cool off as quickly or to such a low temperature.

The second temperature control could additionally be a water temperature adjuster which causes warmer water than the normally chilled water to enter the coils in the  
25 cooling plug when the cooling plug is not in direct contact with the pipe wall.

As a further alternative, the second temperature control may be an external heater such as a band heater  
30 located outwardly around the cooling plug. This band heater will provide heat to the cooling plug. The external heater will only be operative when there is no direct contact between the molten plastic and the pipe wall and the external surface of the cooling plug.

35

Figures 4 through 7 show different sequences of

- 9 -

operation of a temperature controlled cooling plug according to the present invention. In Figure 4 the entirety of the outer surface of cooling plug 35 is in contact with the first wall portion of the pipe wall.

5 The belled coupling wall portion 27 is located upstream in the direction of pipe production relative to the cooling plug.

10 The cooling plug of Figure 4 receives chilling water at normal chilling temperatures over the entire length of the cooling plug.

15 In Figure 5 the entirety of the exterior surface of the cooling plug is still in direct contact with the plastic of the first wall portion of the pipe. However, bell portion 27 is approaching a position in which it will soon move over the cooling plug. This is the position in which the second temperature control will initiate its operation at the upstream end of the cooling  
20 plug. The tempering effect on the cooling on the upstream end of the cooling plug will not necessarily have the immediate desired result but will start to take effect when the belled coupling 27 reaches the Figure 6 position. In this position the belled coupling is  
25 approaching the downstream end of the cooling plug which will now be subjected to the control of the second temperature control.

30 As a result of the above once the pipe wall reaches the Figure 7 position the upstream end of the cooling plug will not have dropped to an overly chilled temperature. Therefore, the first wall portion of the pipe wall directly adjacent to and upstream of belled coupling portion 27 is not excessively cooled by the  
35 upstream end of the plug.

- 10 -

Also in the Figure 7 position the second temperature control is shut off at the upstream end of the plug which is once again subjected to the first temperature control i.e., heat applied directly to the upstream end of the cooling plug by the plastic of the pipe wall.

In the Figure 7 position the downstream end of the cooling plug will still be under the influence of the second temperature control until the main pipe body following belled coupling 27 completely covers the entire length of the cooling plug. Once the pipe wall has reached this position the entire plug falls completely under the control of the first temperature control provided by the heat transferring from the pipe wall to the plug.

It is to be noted that at all time cooling water will continue to circulate through the coils of the cooling plug as described later in more detail. However, the temperature of the water introduced to the cooling plug may vary in the different pipe wall positions shown in Figures 4 through 7 of the drawings.

Figure 3 of the drawing shows a preferred embodiment construction of cooling plug 35. In this construction, the cooling plug has a first upstream section 37 and a second downstream section 39. Fluid carrying coils 41 wrap around plug section 37 while fluid carrying coils 43 wrap around section 39. Coils 41 and 43 do not feed into one another.

Provided at the upstream end of die tooling 5 is a water chiller 51. A pump 53 draws water from chiller 51 and forces the water through the die tooling to cooling plug 35.

- 11 -

Pump 53 feeds to a first flow line 59 and a second flow line 69. A water flow control valve 57 is provided at the upstream end of line 59 and a water flow control valve 67 is provided at the upstream end of line 69.

As will be seen in Figure 3, flow line 57 feeds to a water inlet 61 of plug portion 37. This inlet feeds the coils 41 wrapping around plug portion 37.

Once the water from line 59 has completed its passage around the helically wound coils 41 it leaves these coils by means of water outlet 63. Water outlet 63 feeds through return line 65 back to chiller 51.

The water fed along line 69 past control valve 67 feeds to a water inlet 71. This inlet feeds the continuously wound helical coils 43 of the second section 39 of cooling plug 35. The water after having passed through coils 43 exits the second cooling plug section by a water outlet 73 leading to return line 75. Return line 75 carries the water back to chiller 51.

As will be appreciated from the description above there is a continuous flow of water between the chiller and both the first and second sections of the cooling plug. The water fed to the cooling plug sections from the chiller will initially be very cold. However, that water will gradually warm up as it travels through the helical coils in the two cooling plug sections. This is because of the heat to which the chilling water is subjected by the molten plastic of the pipe wall. In a case where the second temperature control comprises a heater externally of the cooling plug, this heater will also have a tendency to warm the water in the cooling plug sections. This water must then be returned to the

- 12 -

chiller where the temperature of the water is lowered before it is returned back to the cooling plug sections.

Using the Figure 3 setup and with the pipe wall in the Figure 5 position for example, valve 57 feeding along 59 to the first cooling plug section 37 would be adjusted to decrease the flow of cooling water to plug section 37. This would be done just in advance of the bell 27 moving onto cooling plug section 37. The water flow to cooling plug section 39 would continue in the normal operating manner with the pipe wall in the Figure 5 position.

When the pipe wall reaches the Figure 6 position and again using the setup of Figure 3 valve 57 would remain in its adjusted position to reduce the flow of cooling water to the first cooling plug section 37. At the same time valve 67 would be adjusted to also reduce the flow of cooling water to cooling plug section 39. This would occur just before the coupling bell 27 moves onto cooling plug section 39.

When the pipe wall reaches the Figure 7 position, valve 57 would be adjusted to its full flow position to resume normal flow of the chilling water to plug section 37. Valve 67 would remain in its flow diminishing position while coupling portion 27 remains over plug section 39.

When the pipe moves back to the Figure 4 position both valves 57 and 67 would be adjusted to their fully open positions to provide sufficient cooling to compensate for the direct contact of the pipe wall with the full exterior surfaces of both cooling plug sections.

Another feature of the present invention is found in the provision of vacuum slits 45 in cooling plug

- 13 -

section 37 and vacuum slits 47 in cooling plug section 39. These vacuum slits are connected to two separate sources of vacuum. The vacuum is used to hold the first wall portion of the pipe wall onto the external surface of the cooling plug. However, when the coupling bell is moved into a position where it is over one of the cooling plug sections the vacuum for that section is turned off. This occurs in conjunction with the operation of the second temperature control to prevent excessive cooling of that section of the cooling plug.

Again, by way of example both full vacuum and full chilling water flow will be provided to both plug sections when the pipe wall is in the Figure 4 position. When the pipe wall is in the Figure 6 position the vacuum is turned off at the first plug section and the first plug section is subject to the control of the second temperature control. Vacuum will still continue to be applied at the second upstream plug section in the Figure 6 position of the pipe wall. Also in this pipe wall position the upstream second plug section 39 continues to be under the temperature control provided by the heat from the pipe wall.

When the pipe wall reaches the Figure 7 position the vacuum is turned off at the upstream plug section 39 and the second temperature control takes over to replace the first temperature control to prevent excessive cooling of the upstream plug section.

In the Figure 7 position the vacuum is turned back on at the upstream plug section 37 and the second temperature control is turned off. The first temperature control provided by the heat coming directly from the pipe wall onto the first plug section 37 is used to prevent this plug section from dropping to an excessively

- 14 -

low temperature.

Although various preferred embodiments of the present invention have been described in detail, it will  
5 be appreciated by those skilled in the art that variations may be made without departing from the spirit of the invention or the scope of the appended claims.



- 15 -

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE  
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A pipe molding system for producing plastic pipe,  
5 said system including a plurality of moving first mold  
block sections and second moving mold block sections, the  
first mold block sections closing with the second mold  
block sections to form a moving mold tunnel, means for  
feeding molten plastic to the first and second mold  
10 blocks sections to form the plastic pipe and a cooling  
plug for setting the plastic pipe in the moving mold  
tunnel, the plastic pipe having a pipe wall with a first  
wall portion which travels over and is in contact with  
said cooling plug and a second wall portion which travels  
15 over and is spaced outwardly away from said cooling plug,  
the first wall portion transferring heat directly to and  
providing a first temperature control to prevent  
excessive plug cooling as the first wall portion travels  
over the cooling plug, said system including a second  
20 temperature control which operates to replace the first  
temperature control in preventing the excessive plug  
cooling as the second wall portion of the pipe wall  
travels over the cooling plug.
- 25 2. The pipe molding system of Claim 1 wherein said  
cooling plug is cooled by a supply of chilled water, said  
second temperature control comprising a water flow  
adjuster to reduce flow of the chilled water to the  
cooling plug when the second wall portion of the pipe  
30 wall travels over the cooling plug.
3. The pipe molding system of Claim 1 wherein said  
cooling plug is cooled by a supply of chilled water, the  
chilled water being at a first temperature as the first  
35 wall portion travels over the cooling plug, said second  
temperature control comprising a water temperature

- 16 -

control which raises temperature of the chilled water above the first temperature as the second wall portion of the pipe wall travels over the cooling plug.

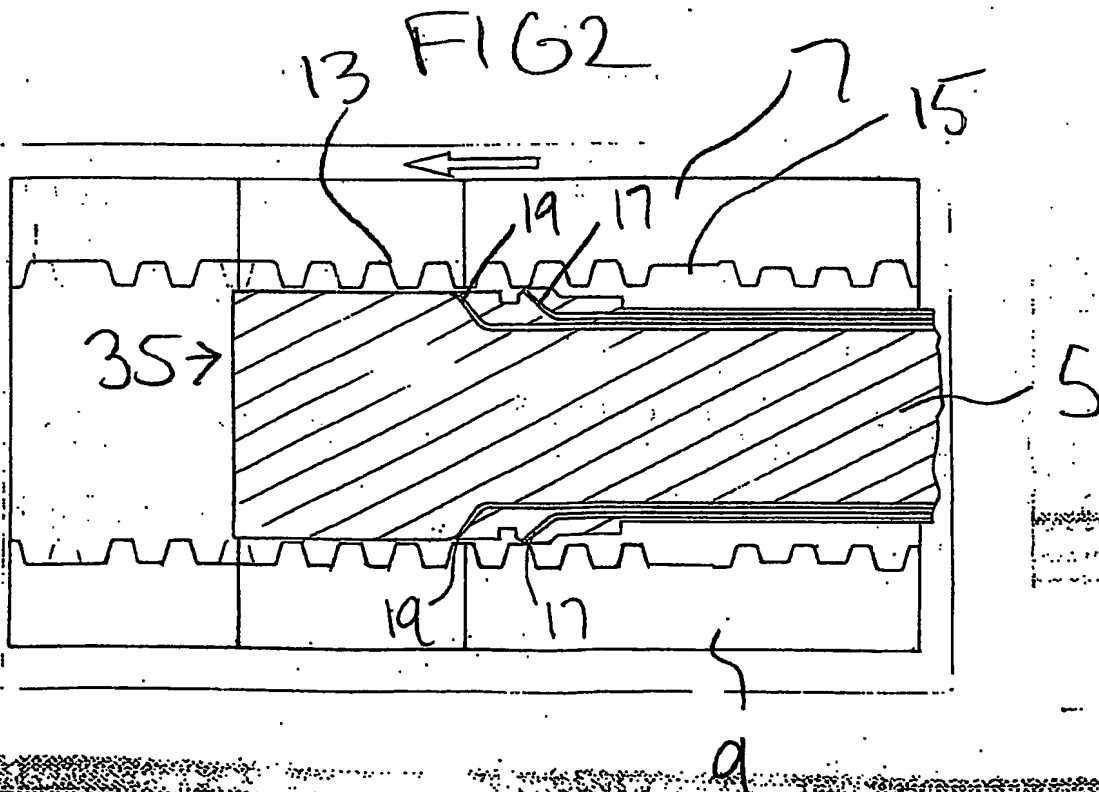
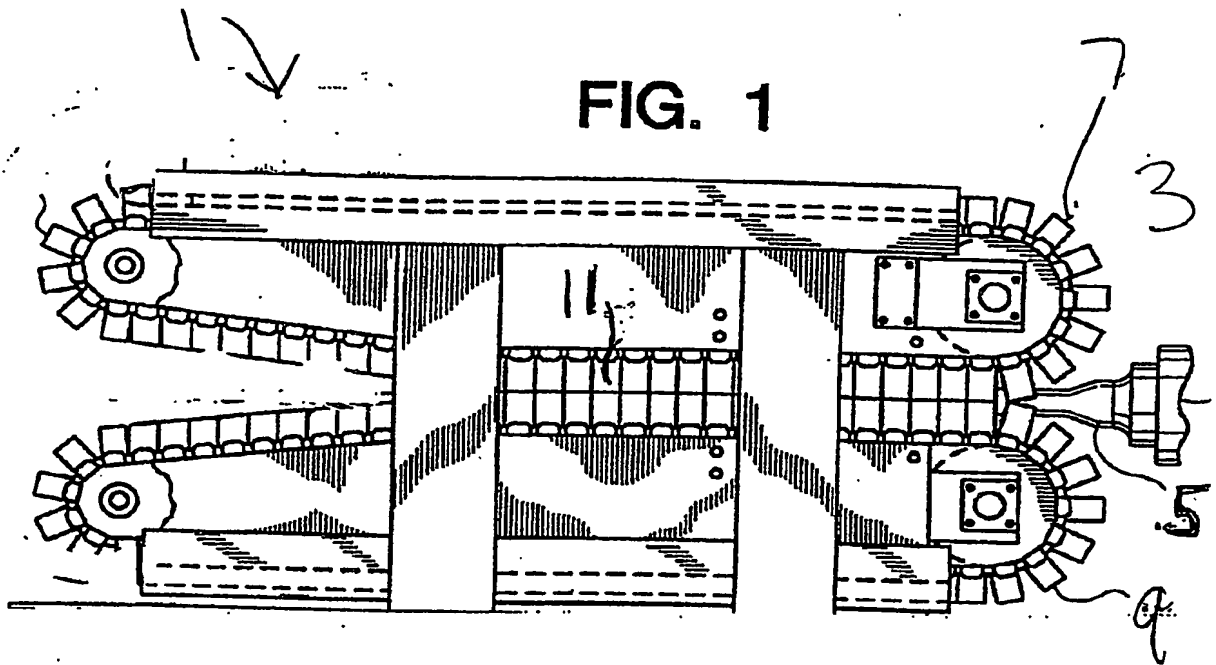
5     4.     The pipe molding system of Claim 1 wherein said  
cooling plug is internally cooled by a supply of chilled  
water, said second temperature control comprising a  
heater externally of and directing heat onto said cooling  
plug when said second wall portion of said pipe travels  
10 over said cooling plug, said heater being inactive when  
said first wall portion of the internal wall of the pipe  
travels over the cooling plug.

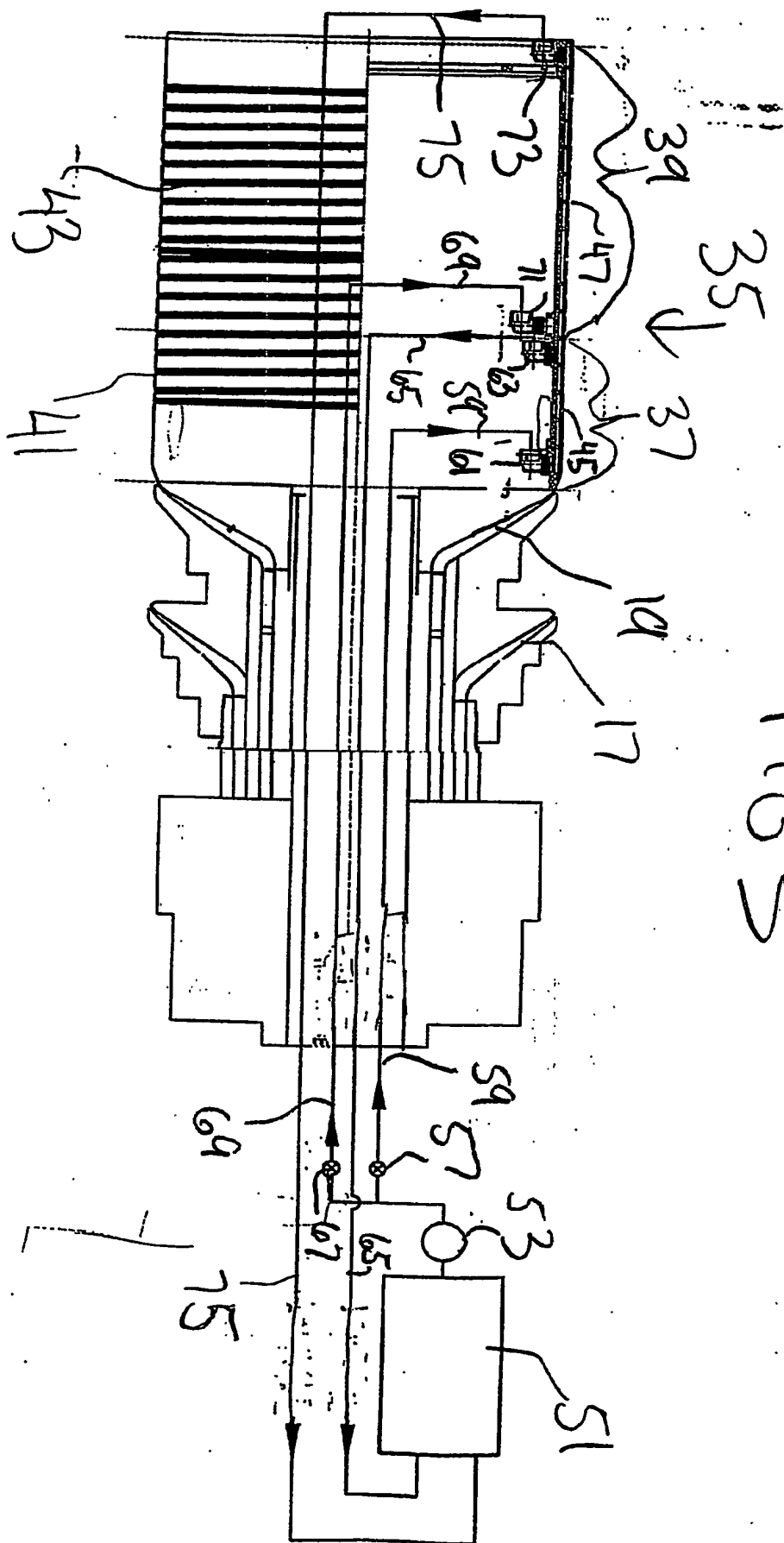
15     5.     The pipe molding apparatus of Claim 1 wherein said  
system includes means to produce vacuum at the cooling  
plug when the first wall portion travels over the cooling  
plug to assist in maintaining the first wall portion in  
contact with the cooling plug, the means to produce  
vacuum being turned off when said second temperature  
20 control is operated as the second wall portion of the  
internal wall of the pipe travels over the cooling plug.

25     6.     The pipe molding system of Claim 1 wherein said  
cooling plug comprises first and second plug sections,  
said first plug section being subjected to the vacuum and  
being temperature controlled only by the first  
temperature control of the heat of the first wall portion  
to prevent the excessive plug cooling as the first wall  
portion travels over the first plug section while, at the  
30 same time, the second plug section is free of the vacuum  
and is subjected only to the second temperature control  
to prevent the excessive plug cooling as the second wall  
portion of the internal wall of the pipe travels over the  
second plug section, and then as the pipe moves along the  
35 mold tunnel, said first plug section being free of vacuum  
and being temperature controlled only by the second

- 17 -

temperature control to prevent the excessive plug cooling  
as the second wall portion of the internal wall of the  
pipe travels over the first plug section while, at the  
same time, the second plug section is subjected to the  
5 vacuum and is temperature controlled only by the first  
temperature control of the heat of the first wall portion  
as the first wall portion of the internal wall of the  
pipe travels over the second plug section.



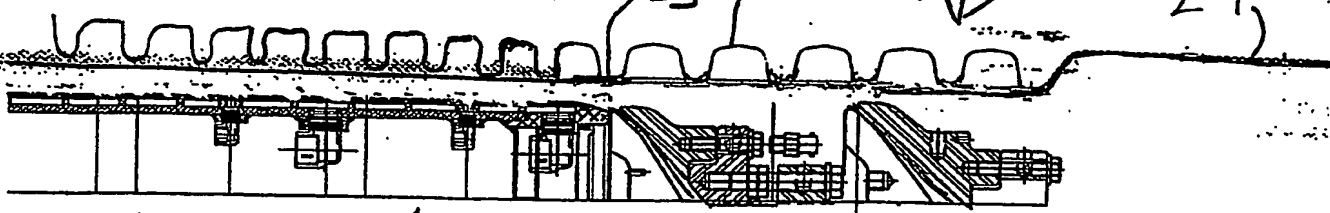


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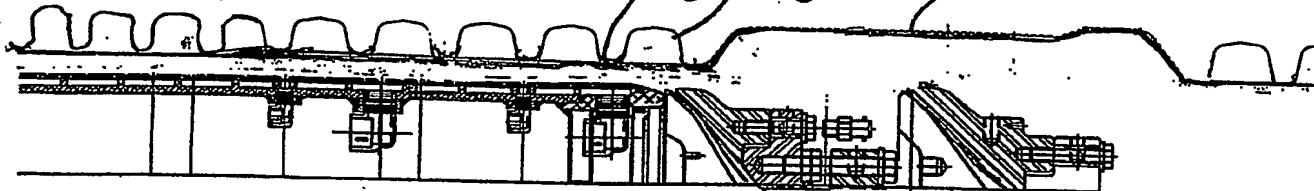


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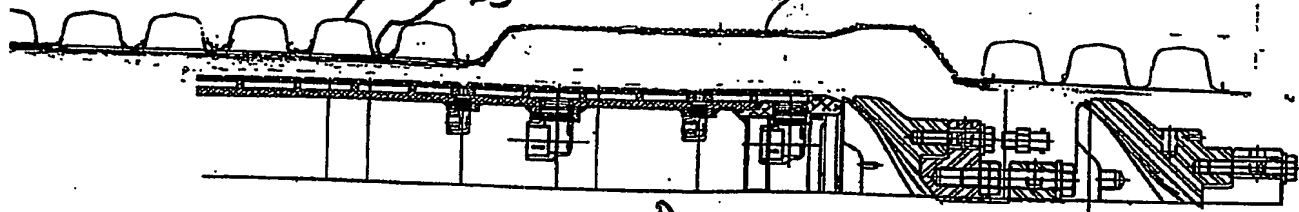
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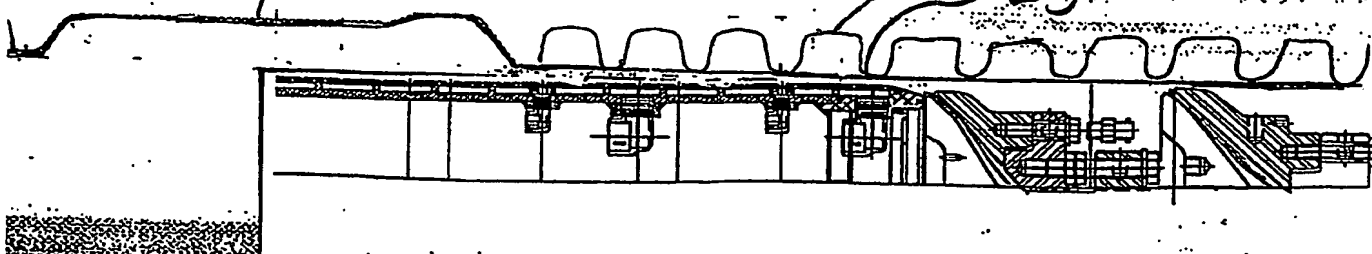
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